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SHALLOW WELLS: AN AREA OF PROMISE

Successful Stimulation Of Low-Rate Wells, p. 21
How To Produce Shallow Crudes, p. 24

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1984 Rig Count To Top Last Year's Average

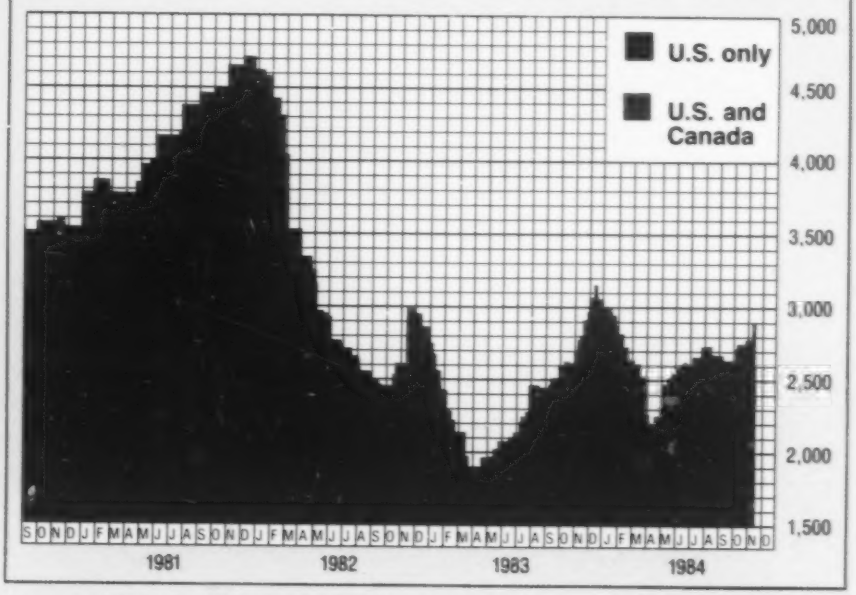
Indications now are that the final U.S. rig count for 1984 will be close to 200 rigs higher than the 1983 average of 2,232. Our projections, made without benefit of either entry or exit polls, are for the year-long average this year to come in at right about 2,415 active rotary rigs.

The count as of this writing, in mid-November, stands at 2,393, but U.S. drillers seem to have broken out of the summer doldrums that had them hovering at the 2,400-mark for four months. They now are approaching 2,600. And, with a strong week by Canadian drillers in mid-November, the overall U.S. and Canadian active rig count is approaching the 3,000-mark for the first time since last January.

Rotary rigs actually making hole in United States & Canada

As reported to International Association of Drilling Contractors by Hughes Tool Co.

	Oct. 22, 1984	Oct. 29, 1984	Nov. 5, 1984	Nov. 12, 1984
Alabama				
Land	16	12	12	13
Inland Waters	3	3	3	3
Offshore	1	1	1	4
Total	20	16	16	20
Alaska				
Land	7	7	7	7
Offshore	7	7	8	9
Total	14	14	15	16
Arkansas	31	24	23	21
California				
Land	88	92	104	103
Offshore	22	24	21	21
Total	110	116	125	124
Colorado	62	60	62	61
Florida	5	5	4	4
Georgia	1	1	1	1
Hawaii	0	0	1	1
Idaho	1	1	1	2
Illinois	49	48	44	43
Indiana	10	10	9	10
Kansas	98	112	130	131
Kentucky	6	6	6	6
North Louisiana	27	30	28	34
South Louisiana				
Inland Waters	50	51	55	56
Land	91	92	92	100
Offshore	143	145	148	143
Total	311	318	323	333
Michigan	40	43	46	43
Mississippi	24	24	27	27
Montana	40	34	45	45
Nebraska	8	6	10	12
Nevada	4	4	5	3
New Jersey				
Offshore	1	1	1	0
New Mexico	102	97	97	91
New York	11	11	7	8
North Dakota	45	39	42	46
Ohio	76	77	80	80
Oklahoma	311	307	308	318
Oregon	1	1	1	2
Pennsylvania	46	47	49	50
South Dakota	2	3	3	3
Tennessee	1	1	0	0
Texas				
Offshore	48	49	51	48
Inland Waters	6	5	4	4
Dist. 1-S. Central Tex.	15	16	15	13
Dist. 2-Middle Tex.	33	35	38	38
Dist. 3-Upper Tex.	111	119	92	97
Dist. 4-Lower Tex.	81	81	82	80
Dist. 5-Northeast Tex.	28	27	22	22
Dist. 6-Far Northeast Tex.	70	70	64	60
Dist. 7B-N. Central Tex.	54	48	52	58
Dist. 7C-W. Central Tex.	66	66	65	67
Dist. 8-Far West Tex.	149	152	166	174
Dist. 8A-West Tex.	77	75	87	85
Dist. 9-N. Tex.	77	86	77	82
Dist. 10-Tex. Panhandle	45	43	40	46
Total	860	863	856	878
Utah	49	44	47	48
Vermont	1	1	0	0
Virginia	3	0	1	1
Washington St.	1	0	0	0
W. Virginia	41	40	34	38
Wyoming	126	129	134	131
Total U.S.	2,511	2,503	2,564	2,597
Canada	265	252	227	280
Canada - Offshore	13	13	13	13
U.S. and Canada	2,789	2,768	2,794	2,900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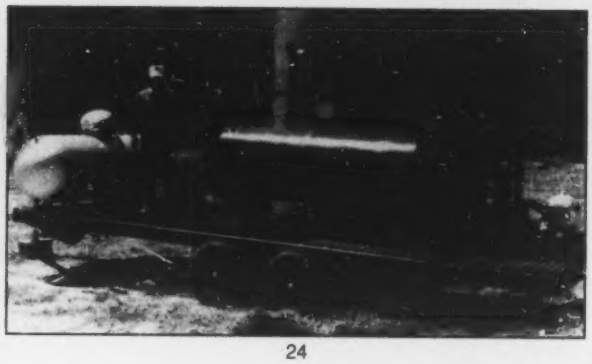

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SHALLOW WELLS: AN AREA OF PROMISE

Shallow Well Stimulation Demands Good Engineering 21

by George E. King, Amoco Production Research. Although any increase in drilling quality or damage removal treatment is an added expense, decreasing formation damage can improve productivity, even on a tight budget.

How To Produce Shallow, High WOR, Heavy Crude 24

by Charles D. Haynes, Belden & Blake Corp. High oil viscosity, corrosive salt water, and directionally drilled wells in isolated locations are common conditions that, when coupled with high produced water content, present an ongoing challenge.

Multidrain Drilling Ups Production 34

Staff Report. Any well that has a low production rate due to low permeability, viscous crude, or low reservoir pressure is a likely candidate for the multidrain system, which can increase production in the same way as an additional well would.

Shallow Well Operations Aren't Always Simple 36

by Steven D. Moore, Drilling Editor. Formation characteristics determined from previous logs and cores can be helpful in selection of the best completion and production methods as well as the best drilling fluid for minimizing formation damage.

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ABOUT THE COVER: Shallow wells, often located in remote locations with harsh environments, account for nearly 70% of producing oil wells in the U.S. (Photo courtesy of Diamond Shamrock Corp.)

NEXT MONTH: The Field Development issue in January covers methods and technology involved in planning and executing drilling and production programs in known fields.

Shallow Wells Aren't Always Simple

by Steven D. Moore, *Drilling Editor*

So what's exciting about a shallow well? To outside observers and even most major operators, very little. Deep wells garnish media attention because of their high costs and potentially high daily production volumes. A good percentage of research – by both major operators and service companies – continues to be directed toward deep wells.

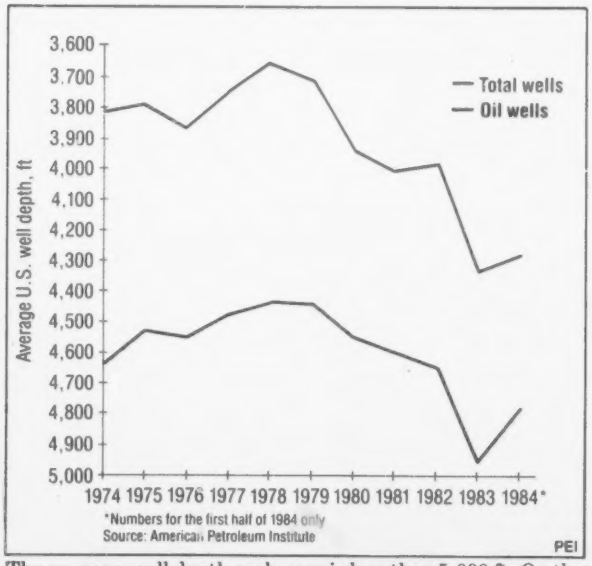
But these trends have not stifled shallow well operations. Shallow wells hold a dominant share of market and are, in fact, the lifeline of independent producers.

Shallow wells are attractive to independents because they allow an operator to spread the risk over several wells. An operator can drill 10 shallow wells for the cost of drilling one deep well. Admittedly, that one deep well could produce more than 10 shallow wells combined, but that deep well could be a dry hole, too.

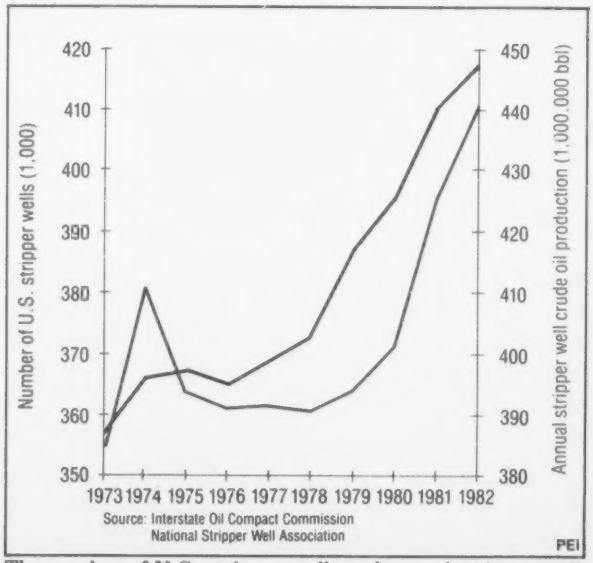
Statistics confirm the industry's dependence on shallow well operations. According to API, wells drilled last year averaged about 4,270 ft in depth. The average oil well was even shallower – approximately 3,650 ft. Of all the wells drilled in 1983, 69% had total depths of less than 5,000 ft.

Nearly 70% of producing oil wells in the U.S. are classified as stripper wells – that is, producing less than 10 b/d of oil. And in virtually every case, a stripper well is shallow.

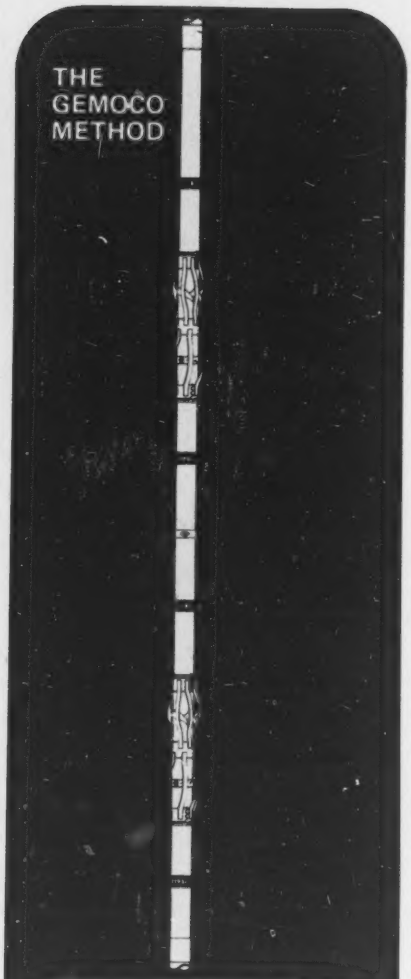
On a national average, stripper wells produce about 3 b/d of oil. In Pennsylvania, the average stripper produces less than 0.5 b/d of oil. Can an operator make money on such low-volume producers? With 416,000 stripper wells producing oil at the beginning of 1983, obviously operators think they are profitable.[1]



The average well depth each year is less than 5,000 ft. On the whole, oil wells have been even more shallow, especially in 1983 when the average oil well was drilled to 3,650 ft. During the last 10 years, about 70% of wells drilled in a given year were drilled to less than 5,000 ft.



The number of U.S. stripper wells and annual stripper well production has increased steadily since the late 1970s. The typical stripper well averaged about 3 b/d during this time period. Note the dramatic jump in annual stripper well production in 1974 after the first Arab oil embargo.



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Cost of drilling and equipping wells–1982

The following table compares the costs of drilling and equipping shallow wells–in Illinois, Indiana, and Appalachia–to the national average. Note the significant cost per foot differential.

	Number of wells drilled	Footage drilled	Total cost, $	Depth per well, ft	Cost per well, $	Cost per foot, $/ft
Illinois	2,856	7,671,190	239,164,565	2,686	83,741	31.18
Indiana	1,012	1,960,915	57,603,679	1,938	56,921	29.38
Appalachia	8,467	29,093,342	1,161,134,621	3,436	137,126	39.91
Subtotal	12,335	38,725,447	1,457,902,865	3,139	118,192	37.65
Total U.S. land	76,565	361,637,121	38,873,419,401	4,723	507,718	107.49

Tight Budgets

Most shallow wells are drilled by smaller companies on limited budgets. To avoid extra costs, many independents will forego seismic surveys and field studies, and instead review data already generated from other sources.

Scrutinizing old logs and well records may uncover a pay zone previously missed. Drilling another 100 ft may tap a second productive interval. Conversely, re-evaluating upper hole sections may detect hydrocarbons that were never anticipated – and therefore overlooked–when the well was originally drilled.

For example, hundreds of wells were drilled to a deep target in the Greybull field of Wyoming beginning in 1918, with operators overlooking the shallow Peavy sand, 250 to 350 ft below the surface.[2] In the late 1950s, someone finally discovered that this 100-ft thick sand was productive. In fact, about 800,000 bbl of high-gravity oil have been recovered from a 60-acre block of the Peavy sand, compared to 250,000 bbl of oil–produced over a 60-year period – from the deeper pay zone across the entire field.

A well tapping the Peavy sand can produce about 10,000 bbl per acre through primary recovery methods. These shallow wells – usually on 2-acre spacings – can be drilled and completed for as little as $20/ft, or approximately $6,000 to $7,000 per well. With the wells initially producing 15 to 20 b/d of oil, payout can occur quickly.

Good Engineering Needed

Drilling a shallow well may not be as demanding as a deeper well, but sound engineering practices are required to successfully exploit a reservoir. Today most shallow wells are drilled under footage or turnkey contracts, but contractors must be capable of providing a usable hole with minimum formation damage. Thousands of wells over the years have been abandoned or have severe production limitations because of poor drilling and completion techniques.

A first consideration in drilling a shallow well is to determine the formation characteristics. From previous logs and cores, the best completion, stimulation, and production methods can be selected. Further, by understanding the formation characteristics, the drilling fluid for minimizing formation damage can be determined.

In many cases the operator should consider air or foam drilling. Air drilling is faster than mud drilling and also reduces the chance for formation damage. Although more surface equipment is needed, air drilling eliminates the cleanup problems encountered with a mud system. In addition, air drilling allows detection of hydrocarbon intervals that could be passed over when using a drilling mud.

A variety of rotary drilling rig types is available for shallow well drilling. Only in a few isolated areas are cable tools employed on a regular basis. Most rigs are truck mounted and highly portable, capable of reaching TD in 2 to 5 days. Usually these portable rigs are capable of running surface casing, as well as a longer production casing string. For extremely shallow wells, a water well rig may be the best option.

Another cost savings consideration is re-entering an old well to reach the drilling objective, thus avoiding the cost of a surface casing string. If this option is unavailable, determine the minimum amount of surface casing that will avoid poten-

tial problems with contamination of the water aquifers and later with well bore stability.

Completion Techniques

If insurmountable formation damage is suspected or if the well is an apparent dry hole, running and cementing a casing string may be an unnecessary expense. To save the cost of a casing string and cement job, some operators run an external packer on the bottom of the casing string to just above the completion zone. The packer is set and a modified drill stem test is run. If the well is unproductive, the packer is released and the casing string retrieved. If the well is worth completing, the casing string is cemented in place by either pumping cement through ports above the packer or down the annulus from top to bottom.

If this type of completion design is combined with an air drilling operation, the potential for formation damage is virtually eliminated. Also, by leaving the productive interval uncased, perforations are not necessary.

Another approach is the tubingless completion. Fluid is produced up the casing, thus one pipe string is eliminated. The technique is particularly effective in low-pressure gas wells where 2⅛- or 2⅞-in. tubing is used as casing.

Some operators use standard tubing for casing in oil wells, too. Instead of sucker rods, operators use 1-in. tubing with a modified pump on the bottom, which enables oil to be pumped up the 1-in. string.

In many areas, stimulation is an important part of the successful completion of a shallow well. Some producers treat the well immediately after the production string is run and the well is perforated. Other operators wait up to 30 days before treating the well. These decisions depend largely on operator preference and formation characteristics.

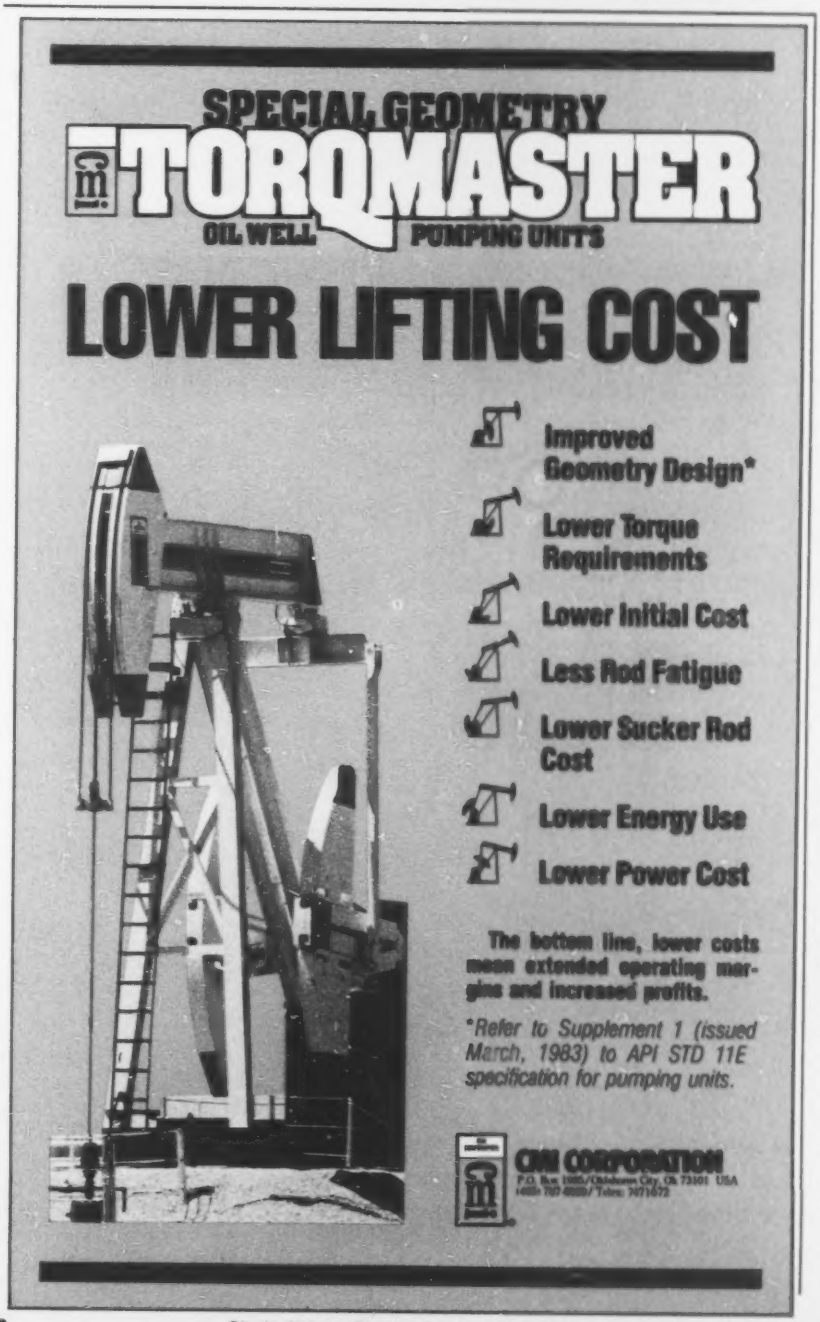
Fracturing techniques vary from area to area, but one of the more interesting methods is used in the Appalachia region for low-pressure wells. The wells are typically open-hole completions, commonly called barefoot completions, and have multiple pay zones.[3]

The well is open hole below the surface casing to TD and a fillback method is used for treating each zone. Sand or pea gravel is pumped down the well, filling the well bore from TD to just below the uppermost zone to be treated. Care is taken in loading the gravel to avoid bridging. A straddle packer is run and set on top of the zone. Next, the zone is treated, typically with a water-base fracturing fluid.

After treatment, the packer is unseated and the well is reverse circulated, washing out gravel between the treated zone and the next lower zone. The process is repeated until the bottom-most zone is treated. This type of stimulation treatment is effective and inexpensive. Occasional problems do arise – for example, the packer fails and must be fished, the treatment comes around the packer, or the treatment goes out of the zone.

One operation given little consideration is swabbing a loaded well.

(Continued)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*Refer to Supplement 1 (issued March, 1983) to API STD 11E specification for pumping units.
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The procedure is straightforward, but if you pull too hard on the formation during swabbing, the formation can start to come in and sand up the well bore.[4] A variety of problems can result, including losing the well completely. At the least, some type of bailing operations will be required.

Production Equipment

The most important parameters in selecting a production system are economics and service reliability. The standard production method for shallow wells continues to be beam pumping units. Beam pumping units, sucker rods, and downhole pumps are readily available and easy to operate and understand.

Other production methods being used with varying success are air and gas lift, and submersible, hydraulic, and progressive cavity pumps.

One method gaining popularity in shallow well applications is the hydraulic pumpjack, which hydraulically moves the sucker rods in and out of the hole. The new generation of hydraulic pumpjacks is lightweight, easy to repair, and cost competitive. In many cases, these pumps have longer strokes than comparable beam pumping units.

Another method finding more use is the progressive cavity pump, which operates much like an auger.[5] Although introduced in 1936, this pump has grown in popularity only recently, partially because of increased production of heavy crudes. The pump has only one moving part – a rotor housed inside a stator.

Because of the pump's simple design, there are only two variables to consider when selecting the right pump size. The first is capacity, which is determined by the size of the cavities formed between the rotor and stator. Larger cavities generate higher flow rates at a given well depth and rotation speed.

The second variable is depth capability, which is determined by the number of sealed cavities formed between the rotor and stator. Generally, the pump will produce at a greater depth and higher pressures when equipped with a longer rotor and stator for a given capacity rating.

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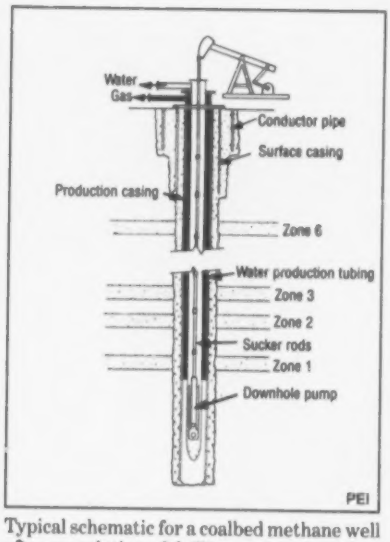
TRW Producing Coalbed Gas



Typical schematic for a coalbed methane well after completion of drilling and casing.

TRW Inc. of Redondo Beach, Calif., a manufacturer of percussion drilling equipment (among other things), has gone into the natural gas business with a unique process that extracts pipeline-quality methane from coal beds.

Recovery and sale of methane from coal deposits near Tuscaloosa, Ala., is TRW's first venture into using its technology to develop energy for commercial business. TRW gas is being recovered from wells completed in Alabama's Black Warrior Basin. Drilling for the project began in 1982.

A second Warrior Basin project is just getting under way and will be developed at the rate of 16 wells per year after field testing and successful negotiation of a gas sale contract.

The program is an outgrowth of a research and development effort begun in 1976 under sponsorship of the U.S. Department of Energy. Currently, TRW is working with the Gas Research Institute to expand the coalbed methane technology.

Production from coalbed reservoirs uses drilling and completion techniques that are similar to those for conventional gas wells. Coalbeds are tight reservoirs and generally require stimulation for commercial levels of production. The coalbeds also have high water-saturation levels, so they require dewatering to increase gas flow.

As indicated in the accompanying illustration, it is most economical to drill into geologic structures with multiple layers of coal seams and to sequentially tap them for methane gas. As water is removed from the coal formation, gas flows into the well casing and moves to the surface under its own pressure. From there, the gas moves through a gathering system to be compressed and dried before delivery to the pipeline.

Kye Trout Picked For Chief Roughneck

Kye Trout Jr., an independent oil producer in the Bismarck, N.D., area, was selected to be the 30th Chief Roughneck during the annual membership luncheon of the Independent Petroleum Association of America in San Diego, Calif.

A native of northeastern Indiana, Trout attended the University of Texas for 3 years, and received his BS degree in geology and petroleum engineering from Penn State University in 1944. While working in the West Texas oil fields during the late 1940s he continued his affiliation with UT, teaching off-campus courses in drilling and production.

He traveled north in the early 1950s to explore the Williston Basin of North Dakota, and became an independent producer in the Cut Bank field in 1955. He began his business of oil and gas and mineral acquisition, development, exploration, and evaluation in Bismarck in 1960.

The Chief Roughneck award was conceived in 1955 by Lone Star Steel Co. as a means of recognizing the nation's leaders in oil and gas exploration and production. This year, as usual, the identity of the new Chief Roughneck was not revealed until the moment of his announcement, which was made at the IPAA luncheon by B. C. Robertson, executive vice president of marketing and sales for Lone Star Steel. During his remarks, Robertson said that, "We in Texas owe a special thanks to Kye Trout because of his guidance and leadership in establishing the nation's first drilling and production technology program at Kilgore College in eastern Texas."

Kye Trout Jr. (right) receives the trappings of office as Chief Roughneck, 1984, from B. C. Robertson, executive vice president, marketing and sales, for Lone Star Steel Co.

Energy Consumption To Rise Next Year

Energy consumption will continue to increase next year, according to the Independent Petroleum Association of America's Supply and Demand Committee, which also expects natural gas production to be significantly higher.

Oil demand is expected to have risen by about 4% this year, ending a 5-year decline. In addition, natural gas production is said to have increased by 5% in 1984, ending a 4-year decline. An additional increase of 2% is projected for 1985.

With regard to overall oil supplies, the committee predicts that, with the strong growth in the U.S. economy during 1984, increased demand will occur for virtually all petroleum products.

In 1985, the committee says, total petroleum supply is expected to be virtually unchanged from 1984. Crude oil imports, however, are predicted to be up close to 260,000 b/d, while product imports should drop by 50,000 b/d.

The committee anticipates demand for oil to average 15.9 million b/d next year, up only slightly from the 15.8 million b/d estimated for 1984.

HNG Completes Dakota Wildcat

HNG Oil Co. has successfully completed a wildcat well in McKenzie County, North Dakota. It tested 500 Mcfd of natural gas and 336 b/d of oil on a 20/64-in. choke at a flowing tubing pressure of 1,800 to 1,850 psi. Perforations are in the Red River C zone at 13,801-18 ft.

Total depth of the well, HNG Neer No. 11-1, is 13,950 ft.

Modest Gain Seen In International Rig Count

Strong showings by European, Latin American, and South Pacific drillers led to a 15-rig gain in the International Rotary Drilling Rig Report during the September 1983 to September 1984 period, according to Hughes Tool Co. of Houston.

Europe picked up 36 active rigs during the year, most of them traceable to the UK, Italy, and Holland. Latin America, led by Mexico, added 11 rigs. The South Pacific, paced by Australia, showed a 10-rig increase.

Among the losers during the period covered by this report is Africa, with a loss of 26 active rigs – 14 of them in Algeria. The Far East was off by 14 rigs, 11 of them in Indonesia, and the Middle East experienced a 3-rig decline.

The full tally follows:

International Rotary Rig Activity, as reported by Hughes Tool Co.
(Figures in parentheses indicate how many of each country's rigs are offshore rigs.)

	Sept. 1983	Aug. 1984	Sept. 1984
Africa			
Algeria	40	26	26
Angola	10(8)	7(5)	7(5)
Benin	1(1)	1(1)	1(1)
Cameroun	5(5)	5(5)	5(5)
Gabon	6(6)	6(5)	6(5)
Ivory Coast	1(1)	2(2)	2(2)
Libya	27(2)	25(2)	24(2)
Nigeria	16(6)	11(5)	11(5)
Rep. of Congo	4(4)	3(3)	3(3)
Rep. of Zaire	2(1)	3(1)	3(1)
Somalia	0	1	1
South Africa	2(2)	2(2)	3(2)
Sudan	5(1)	1	1
Tanzania	1	1	1
Tunisia	5(2)	5	6
	130(39)	103(31)	104(31)
Europe			
Austria	9	7	4
Denmark	5(4)	3(3)	3(3)
France	20(1)	22(1)	20

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Germany	24	20	23
Greece	3(1)	4(1)	4(1)
Holland	15(7)	18(10)	18(10)
Ireland	1(1)	2(1)	2(1)
Italy	20(5)	29(6)	29(6)
Norway	7(7)	9(9)	9(9)
Portugal	1	0	0
Spain	9(3)	11(4)	10(4)
UK	45(43)	65(59)	61(55)
Yugoslavia	14(2)	27(2)	27(2)
	174(74)	217(96)	210(91)
Far East			
Bangladesh	2	3	5
Brunei	9(7)	9(7)	9(7)
Burma	31(1)	33(1)	34(1)
India	57(16)	57(17)	57(17)
Indonesia	93(27)	82(28)	82(28)
Japan	20(1)	16(3)	19(3)
Malaysia	10(10)	9(9)	9(9)
Pakistan	17	16	16
Philippines	7	3	2
Taiwan	5(1)	4(1)	7(1)
Thailand	14(7)	11(6)	12(6)
	265(70)	243(72)	251(72)
Latin America			
Argentina	84	92	94
Barbados	1	2	2
Bolivia	8	6	6
Brazil	78(27)	67(22)	72(26)
Chile	6(3)	6(3)	6(3)
Colombia	13	19	17
Costa Rica	1	1	1
Ecuador	5	3	2
Guatemala	1	1	1
Mexico	185(28)	192(29)	200(32)
Peru	16(6)	18(7)	16(7)
Trinidad	9(4)	7(2)	8(2)
Venezuela	36(12)	27(9)	30(9)
	443(80)	441(72)	454(79)
Middle East			
Abu Dhabi	29(19)	30(20)	30(20)
Bahrain	1	0	0
Dubai	8(5)	6(4)	6(4)
Egypt	30(13)	35(21)	34(20)
Iran	20(2)	20(2)	20(2)
Iraq	18	18	18
Jordan	3	3	3
Kuwait	6	6(1)	6(1)
Oman	13	11	11
Qatar	3(2)	2(1)	2(1)
Saudi Arabia	25(13)	14(5)	14(5)
Syria	16	25	25
Turkey	24	24	24
Umm Al Qaiwain	1	0	0
South Yemen	0	1	1
	197(54)	195(54)	194(53)
South Pacific			
Australia	27(11)	40(12)	38(10)
New Zealand	2	1	1
Papua New Guinea	1	1	1
	30(11)	42(12)	40(10)
Totals	1,238 (328)	1,241 (337)	1,253 (336)

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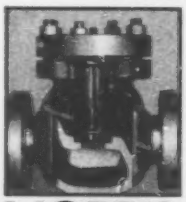

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Letters

TO THE EDITOR:

I contend that it is unrealistic to write a totally Republican-opinionated article via Mr. W. B. Bleakley (Course of Oil, PEI, September 1984, p. 6) as if all your subscribers are Republicans.

I do not believe the name "Petroleum Engineer" means that you must be a Republican to appreciate your magazine, although I have never seen the Democratic view expressed.

George E. Coleman
Farmington, N.M.

TO THE EDITOR:

We would be interested in receiving a copy of the Grace Commission Report mentioned in your September 1984 issue (Comment, p. 112).

Please forward a copy to my attention.

Ronald S. Schraeder
F&M Oil Co. Inc.
Wichita, Kans.

Copies of the entire two-volume, 656-page report are hard to come by, but a report on the report is available from the Foundation for the President's Private Sector Survey on Cost Control Inc. at 1511 K Street N.W., Suite 600, Washington, D.C. 20005. – Ed.